UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
WASHINGTON, D. C.
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ADVANCE REPORT

on the

SEDIMENTATION SURVEY OF LAY RESERVOIR

CLANTON, ALABAMA

January 27 - July 24, 1936

by

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Sedimentation Studies.

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ADVANCE REPORT ON THE SEDIMENTATION SURVEY OF LAY RESERVOIR CLANTON, ALABAMA

GENERAL INFORMATION

Location (fig. 1):

State: Alabama.

Counties: Chilton, Coosa, Shelby, and Talladega. Tps. 21 and 22 S., Rs. 1 and 2 E., Huntsville meridian; Tps. 23 and 24 N., Rs. 15 and 16 E., St. Stephens base and meridian.

Distance and direction from nearest city: About 12 miles northeast of Clanton, and 50 miles southeast of Birmingham.

Drainage and backwater: The dam is on the Coosa River. Water is also impounded on Paint, Waxahatchee, Slaughter, Spring, Peckerwood, Cedar, and Beeswax Creeks and numerous smaller tributaries.

Ownership: Alabama Power Company.

Purpose served: Hydroelectric power development.

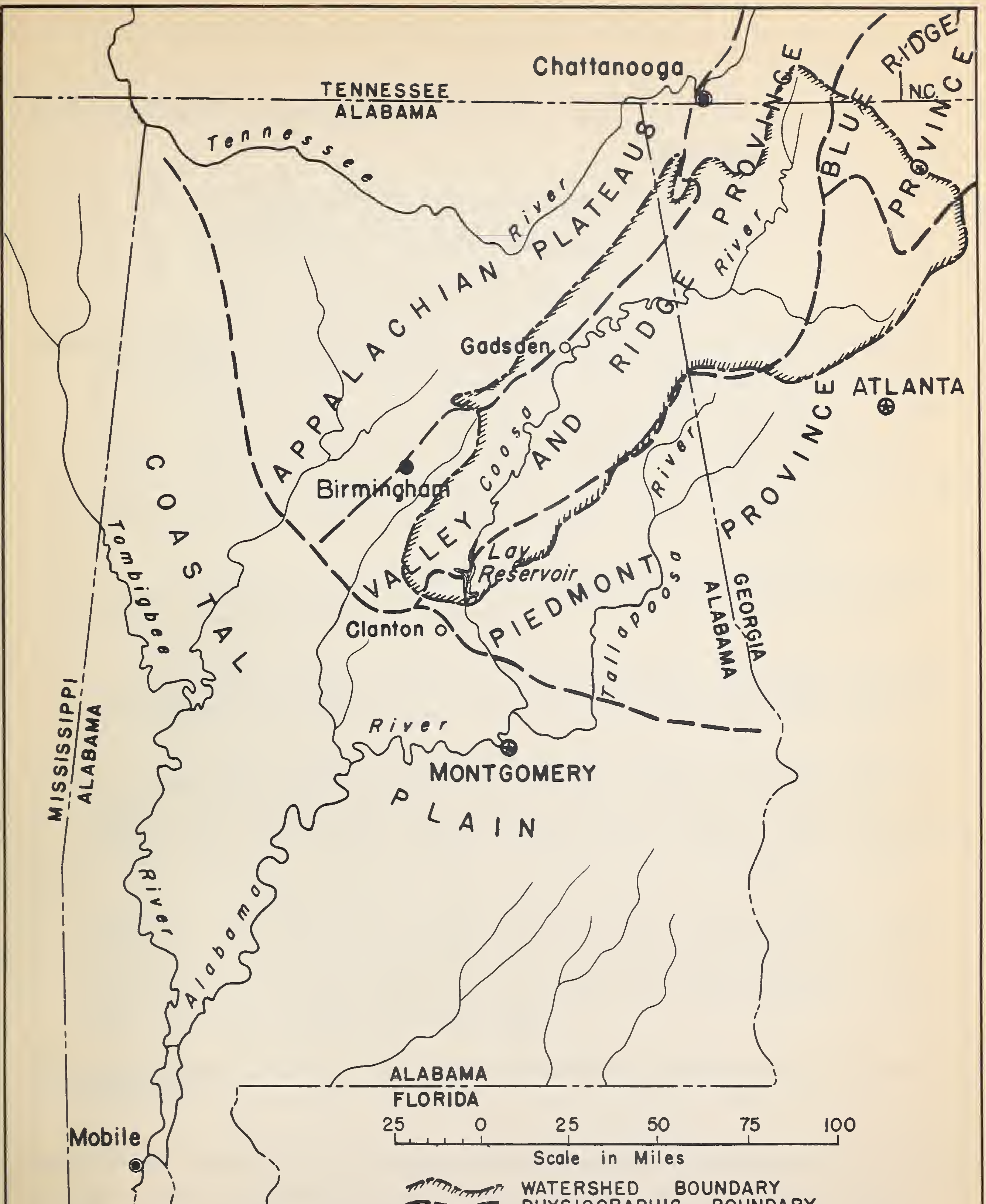
Description of dam: Lay Dam is a gravity-type structure of cyclopean-concrete masonry with power-house built into the west end. It has an overall length of 1,543 feet and is 77 feet high, including the modified Stoney spillway gates across the top.

The spillway, consisting of 26 sections with 14- by 30-foot gates along the crest of the dam, has a total length of 930 feet, including piers between the spillway gates, and a net crest length of 780 feet. The elevation of the tops of the gates, which determine crest level, is 420 feet (local datum).

Date of completion: Storage began in December 1913, about 4 months before final completion of the dam. Average date of survey: May 1936. Age (period of storage): 22.3 years.

Length of lake (original and present): 24 miles.

Area of lake at crest stage (original and present): 6,698 acres.



LOCATION AND GENERAL RELATIONS OF LAY RESERVOIR AND ITS WATERSHED.

Figure 1

Storage capacity at crest stage: (Determined by this survey)

	Acre-feet
Original........................	156,525
Present.........................	138,520
Loss by silting.................	18,005

General character of reservoir basin: Lay Reservoir has a channel-type basin with a length of 24 miles and an average width of about 2,000 feet (fig. 2, following p. 13). In many reaches the lake is confined essentially to the pre-lake channel, and it rarely exceeds twice the original channel width. Through the upper 18 miles of its length the reservoir lies in an open valley less than 150 feet deep, carved in Paleozoic limestones, shales, and dolomites. 1/ In the lower 6 miles the valley sides are steeper and the channel is incised 300 feet into the Ashland Plateau, which is underlain by resistant lower Paleozoic slates and phyllites. 1/

The change in the underlying formations from limestones and shales to more durable slates is reflected by abrupt changes in the character of the stream channel at the contact:

(1) The channel follows a moderately winding course from the head of the reservoir to this contact, and then continues almost in a straight line through the Ashland Plateau into the Coastal Plain to the south.

(2) The average width of the original channel increases abruptly from less than 1,000 feet above the contact to more than 2,000 feet below. About a mile below the contact, however, there is a short bottleneck, known as the Narrows, which is about 600 feet wide. This constriction is apparently due to exceptionally resistant beds in the slate series.

(3) A profile of the Coosa River prepared by U. S. Engineers in 1889 shows that there is an abrupt increase in the gradient of the original channel from about 2 feet per mile on the limestones and shales in the upper part of the reservoir to 7 feet per mile on the slates in the lower part. The profile of the lower reach is also more irregular, with many deep pools alternating with shoals.

Area of watershed: 9,087 square miles, according to records of the Alabama Power Co.

1/ Adams, G. I., Butts, Charles, Stephenson, L. W., and Cooke, Wythe, Geologic map of Alabama, accompanying Geology of Alabama: Ala. Geol. Survey Special Report No. 14 (Prepared in cooperation with U. S. Geol. Survey), in pocket, 1926.

General character of watershed:

Physiographic setting.-- The watershed of the Coosa River above Lay Dam is roughly 50 miles wide by 180 miles long, and extends from the approximate center of Alabama northeastward into parts of Georgia and Tennessee. The Coosa Valley forms the southernmost part of the Valley and Ridge province of the Appalachian Highlands; the watershed, however, overlaps slightly into the Appalachian Plateaus on the west in Alabama and into the Piedmont province on the east in Alabama and Georgia, and includes also the southern tip of the Blue Ridge province in northwestern Georgia (fig. 1).

Topography.-- Great diversity of topography characterizes the watershed, as is indicated by its extension into four physiographic provinces. More than 60 percent of the area, however, lies in the Valley and Ridge province, typified by long parallel ridges and valleys, with the valley belts predominating. The ridges generally rise 300 to 500 feet above the valley floors. The extreme western edge of the watershed lies in the Appalachian Plateaus, characterized by submaturely dissected plateaus of moderate to strong relief. Along the Tennessee-Coosa divide a relief of 200 to 400 feet is typical. Considerable areas along the eastern border of the watershed lie on the mature but less sharply dissected Piedmont peneplain, with a relief of 100 to 200 feet. The extreme headwaters of the Coosa River drain the subdued mountains, with relief up to 2,000 feet, which form the southern end of the Blue Ridge province.

The average gradient of the Coosa River between Rome, Ga., and the head of Lay Reservoir is approximately 1 foot per mile.

Geology:-- About 70 percent of the drainage area lies on folded and thrust-faulted Paleozoic sediments, including, in approximate order of areal extent, Cambrian limestone and shale, Cambrian-Ordovician limestone, Pennsylvanian shale and sandstone, Mississippian sandstone and limestone, and Cambrian quartzite and slate. These rocks crop out in more or less parallel but interrupted belts trending northeastward with the regional structure of the Southern Appalachians.

The remaining 30 percent of the watershed, in eastern Alabama and northwestern Georgia, is underlain by pre-Cambrian schists and associated small bodies of gneiss, marble, and volcanic rocks.

Soils.-- A wide variety of soil types has been developed under the various conditioms of geology, topography, and climate existing in the watershed. In general, the pure limestones give rise to clay loam and silt loam, the dolomites or cherty limestones to sandy or gravelly loams, the shales to silt loam, the sandstones to sandy loam and silt loam, and the schists to more or less gravelly silt loams, sandy loams, and clay loams. The soils range in color from gray to brown and are

commonly tinged with various shades of red and yellow. The principal soil types in the four physiographic divisions are as follows:

Valley and Ridge province: Decatur, Colbert, and Dewey clays, clay loams, and fine sandy loams on the valley floors; and Clarksville, Fullerton, and Montevallo soils, derived chiefly from cherty limestones, on the hills and ridges. The valley lands have a heavy subsoil and absorb water slowly, but the sandy soils of the mountain tops are friable and absorbent.

Piedmont province: Cecil, Davidson, Madison, Appling, Louisa, and Talladega soils, including clays, clay loams, and fine sandy loams. These soils have moderately heavy to heavy clay subsoils, and generally occur on rolling to hilly surfaces.

Blue Ridge province: Cecil sandy loam and clay loam, Louisa loam, sandy loam, and clay loam, and soils of the Davidson, Mecklenburg and Appling series.

Appalachian Plateaus: Hartselle, Hanceville, and Montevallo soils, principally silt loams, shale loams, and sandy loams. Large areas of Rough Broken, Rough Mountainous, and Rough Stony Land are also included.

In addition to the above groups there is a strip of first and second bottoms along the Coosa River ranging from about a half-mile to a mile or more in width. The second bottoms are represented by the Cahaba, Elk, Holston, Wickham, and Waynesboro series, and the overflow lands principally by the Huntington and Holly series. All these soils occur on nearly level surfaces and absorb water readily.

Erosion conditions.-- Removal of topsoil by sheet and gully erosion has gained considerable headway in most parts of the Coosa River watershed. The rate of erosion has been increased by deforestation and annual burning of the forest litter of the extensive timbered lands, and by unwise farming practices in the cultivated areas. According to reconnaissance erosion surveys of Alabama, Tennessee, and Georgia in 1934, about 80 percent of the watershed has undergone moderate to severe sheet erosion with occasional gullies, 10 percent has slight to moderate sheet erosion with gullies rare or absent, and the remaining 10 percent has little or no accelerated erosion.

More than half of the drainage area in Alabama, including the undulating valley lands and the rolling Piedmont area, has lost 75 to 100 percent of its surface soil.[2] The nonabsorbent valley soils have

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[2] Stroud, J. F., and others, Report on the Coosa River watershed, Region No. 2, Alabama: Soil Conservation Service, unpublished manuscript, p. 12, Jan. 15, 1937.

in the past been commonly planted to clean-tilled crops, the rows running straight without regard to slope, and no control of surplus rainwater has been established. As a result large areas of these once fertile soils have been destroyed for agricultural use. The Piedmont soils, on hilly to rolling surfaces, have also been exposed to serious erosion by the conversion of virgin forests into clean-tilled crop lands with little or no protection against surplus run-off. Many fields have been destroyed, abandoned, and have reverted to forest. In the Georgia section of the watershed severe sheet erosion has affected only a few small scattered areas in the Piedmont.

Moderate sheet erosion, with occasional gullies, characterizes the sandy soils of the undulating to rolling mountain tops west of the Coosa River. These soils are less severely eroded than the valley soils because of their friable structure and the better farming methods that generally prevail. Moderate sheet erosion has also occurred on the greater part of the rolling Piedmont soils of the Georgia section.

Slight sheet erosion with occasional gullies is confined largely to the rougher timbered areas which form a discontinuous belt trending northeastward from Lay Reservoir and including the Talladega Hills, and to certain of the Appalachian ridges northwest of the Coosa River near Gadsden, Ala. On some of the forested lands, however, steep slopes and the destruction of the forest litter by annual fires have caused erosion to take a very severe toll. 3/

Little or no erosion has occurred on the first-bottom lands and level terraces along the major streams, and a few interstream areas in the Georgia Piedmont.

Land use.-- Approximate proportions of the Lay Reservoir watershed devoted to the principal land uses are as follows:

	Percent
Forest......................	60
Cultivated..................	30
Pasture.....................	10

3/ Stroud, J. F., Op. cit., pp. 11-12.

The principal species in the forested areas are longleaf and shortleaf pines; red, black-jack, post, willow, and white oaks; poplar, sweetgum, maple, dogwood, cedar, elm, beech, and willow. The pasture lands are grazed by roaming livestock, including cattle, a few hogs, and some sheep in the mountainous areas. The principal crops, in approximate order of importance, are cotton, corn, oats, rye, wheat, sorghum, potatoes, peas, and other vegetables. Some fruit is grown, principally in the broad valleys and to some extent on the steeper slopes.

Mean annual rainfall: 54 inches.

Mean annual inflow (19-year period, 1914-15, 1916-17 to 1933-34):

	Second-feet	Acre-feet per year
Maximum (1919-20)..........	25,561	18,505,320
Minimum (1924-25)..........	8,881	6,429,550
Average for period.........	15,526	11,240,300

Note: To obtain the above figures U. S. Geological Survey discharge measurements on the Coosa River near Childersburg, about 10 miles above the head of the reservoir, were increased 8.3 percent for flow from the intervening drainage area. The drainage area above the gaging station is 8,390 square miles, compared with 9,087 square miles above Lay Dam.

Power development: The installed power equipment at Lay Dam consists of 6 turbines, 4 of which are rated at 17,500 horsepower, 1 at 19,500 horsepower, and 1 at 20,500 horsepower; and 6 generators, all rated at 13,500 kilovolt-amperes. Four units were installed in 1914, one in 1916, and one in 1921. The present and ultimate plant capacity is 110,000 horsepower. The operating head with full reservoir is 70 feet. Under full plant operation with full reservoir, the draft is 16,000 cubic feet per second. This is usually more than equalled by inflow, and consequently, aside from minor fluctuations, there is no draw-down.

HISTORY OF SURVEY

The sedimentation survey of Lay Reservoir was made during the periods January 27 - April 10 and May 26 - July 24, 1936, by the Eastern Reservoir Party, Section of Sedimentation Studies, Division of Research. The personnel consisted of L. M. Seavy, party chief, E. H. Moser, Jr., assistant chief, M. P. Connaughton, and George Sohn, assisted during various periods by F. F. Barnes, L. C. Gottschalk, and A. B. Taylor. The following men, temporarily assigned to the party from the Regional Office at Spartanburg, S. C.,

assisted during the second part of the survey: W. E. Dickerson, George Elias, Ray Groover, F. W. Morrill, and J. S. Rosenberger. A preliminary reconnaissance of the reservoir and watershed was made by D. H. Eargle.

Original and present capacities and silt volumes were determined by the range method of survey. 4/ The crest-level contour used in this survey was taken from maps of the reservoir on a scale of 400 feet to the inch, made prior to construction of the dam. The Alabama Power Co. mapped all the original basin except the extreme upper end, which was mapped by the U. S. Engineers. Occasional small sections of shore line were remapped in the present survey where greater detail was required or where the original shore line had been shifted by wave erosion.

A primary control net of 72 stations was expanded over the main body of the lake by triangulation from 4 chained base lines ranging from 1,000 to 2,600 feet in length. For control on the tributary arms stadia traverse lines were extended from the triangulation net and checked wherever possible by intersection. The control and range location in all the main basin except the narrower upper end was carried out on a scale of 1,000 feet to the inch; the tributary arms and the upper 4.5 miles of the lake proper were worked on a scale of 400 feet to the inch. All triangulation stations, range ends, and cut-in stations were marked with iron pipe set in concrete and stamped with the station numbers, to provide a base for future resurveys.

A total of 153 silt ranges were sounded and spudded. Where deposits were exceptionally thick, as on deltas and silt bars and islands, and on exposed deposits along the shore, a soil auger was substituted for the standard silt-sampling spud in determining the character and thickness of sediment.

ACKNOWLEDGMENTS

The Soil Conservation Service acknowledges the generous cooperation and interest of the Alabama Power Co. during the course of the survey. F. E. Hale, engineer of the Company, supplied maps and general information on the reservoir. S. R. Powers, superintendent of the Lay Dam hydroelectric plant, placed boats, storage space, sand for concrete monuments, records of hourly gage readings, and other valuable data at the disposal of the party.

SEDIMENT DEPOSITS

Character of sediment.-- The sediment in Lay Reservoir consists predominantly of fine, even-textured medium-brown silt, which locally gives

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4/ Eakin, H. M., Silting of reservoirs: U. S. Dept. Agr. Tech. Bull. 524, pp. 129-135, 1936.

place to medium to coarse sand, or is admixed and interstratified with sand and vegetal material in variable proportions.

In the lower 5 miles of the main basin, from the dam to the Narrows (fig. 2, following p.13), the sediment is practically all silt. Between the Narrows and the mouth of Peckerwood Creek occasional sandy deposits are interspersed in the silt, and above Peckerwood Creek silt gradually decreases in importance until it is entirely replaced by sand about 2 miles above the mouth of Cedar Creek. The sand deposits gradually diminish in thickness upstream and finally thin out entirely at Mardis Ferry, 4 miles below the head of the reservoir.

In all the tributaries except the upper half of the Waxahatchee Creek arm the sediment is chiefly silt, with only slight admixtures or local deposits of sandy sediment. Predominantly sandy deposits of small size occur at the heads of the Paint Creck, Spring Creek, and Peckerwood Creek arms. The sediment in the upper half of the Waxahatchee Creek arm is generall sandy, pure silt occurring only in the back-channel near the southwest share in segments 54, 55, and 57, and in the main channel on ranges R464-R465 and R470-R472 (fig. 2). On the two uppermost ranges on Waxahatchee Creek extremely coarse sand and gravel occur. No sediment was found in the upper mile of backwater on this stream.

Vegetal debris, ranging from leaves to tree trunks, is a common constituent of the reservoir deposits and is locally very abundant. In the main basin large accumulations were noted just above the dam, in segments 30 and 34 opposite the mouth of Waxahatchee Creek, and in segment 77 just above the Narrows. Other large accumulations occur at the head of the Paint Creek arm and in segments 35, 36, and 50-53 on Waxahatchee Creek. The determination of silt depths at these localities was very difficult, because the spongy, matted leaf deposits were almost impossible to penetrate with the spud.

The color of the reservoir sediment is predominantly grayish brown, grading locally into various shades of yellowish gray, greenish gray, and dark gray. When it first enters the reservoir the silt is deep reddish brown, as shown by the color of the water after a rain and as would be expected from the prevalence of red soils in the watershed. After deposition under water the red iron oxide is subject to reduction, presumably through decomposition of included organic matter, and consequently the sediment tends to change from brown to dark gray, as in certain small bays opposite the mouth of Waxahatchee Creek. Where the organic matter is abundant the sediment may become black through complete carbonization. In most of the reservoirs of the Southeastern States the silt is typically gray, a brownish tinge being present only in the upper, most recently deposited layers, or in deposits subject to periodic exposure to the atmosphere. The distinct brown color of most of the Lay Reservoir sediment, even at depths of several feet below the surface of the deposits, is exceptional. Just why the older deposits

have escaped deoxidation to the usual gray color, especially in the presence of abundant organic matter, is not clear, but is doubtless related to the unusually high iron content of the parent soils.

Distribution of sediment.-- The extent of silting in the various parts of the reservoir is brought out in table 1 and figure 3. In preparing the table the main basin was divided into three sections, each of which is characterized by more or less uniform sedimentation conditions. The data reveal that more than 50 percent of the total reservoir sediment has accumulated in the lower 6 miles of the 24-mile reservoir, and that only 3.35 percent occupies the upper 9 miles. This concentration of sediment in the lower part of the reservoir, rather than near the head of backwater, is the result of several factors:

(1) The predominance of suspended silt and clay in the incoming sediment load. It is estimated that sandy deposits, confined principally to the upper section of the Coosa River arm and the upper half of the Waxahatchee Creek arm, comprise less than 4 percent of the total reservoir sediment.

(2) A low capacity-inflow ratio, which results in the continuous passage of a large volume of water through the reservoir and over the spillway.

(3) The narrow, channel character of the reservoir basin, as a result of which strong currents are maintained far down the reservoir.

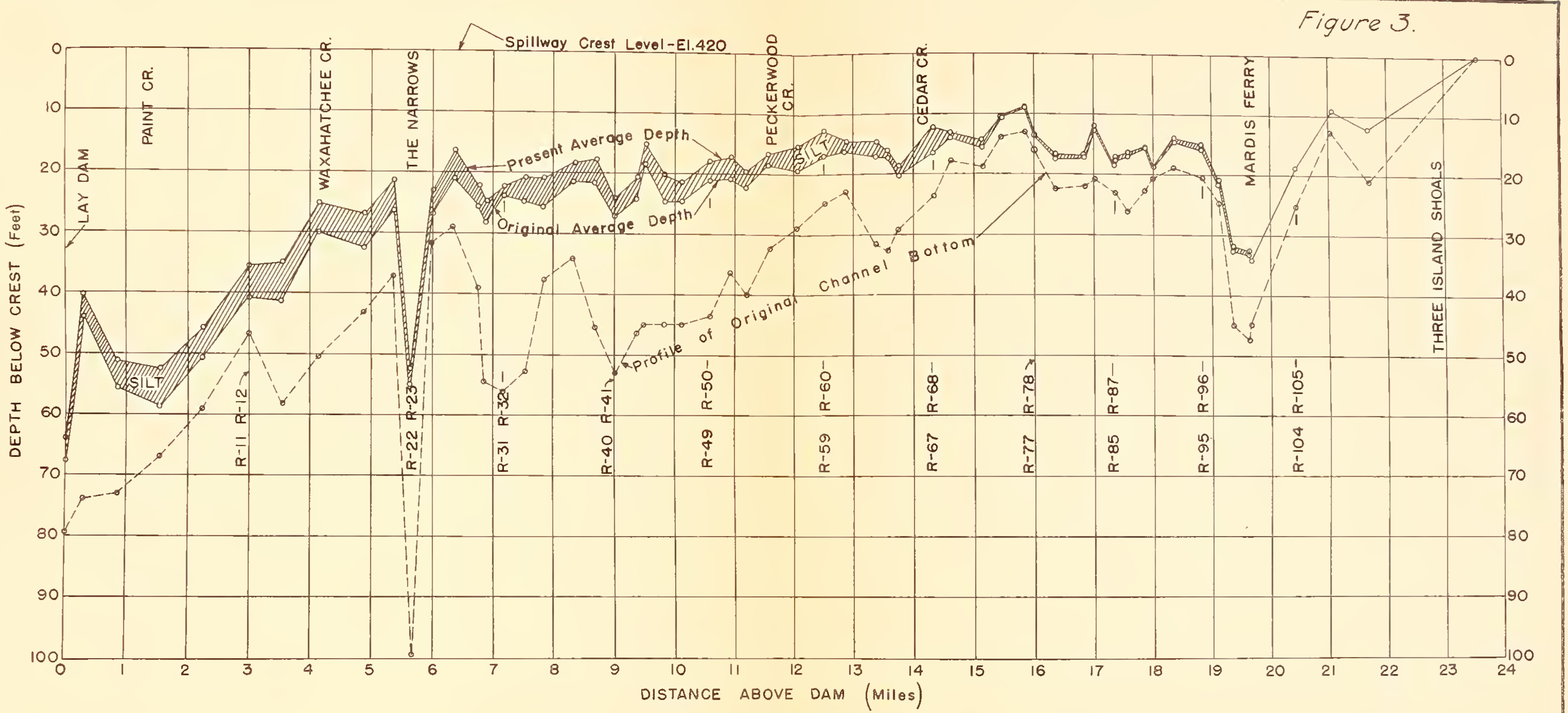
These same factors point to the passage of a large but indeterminate fraction of the incoming sediment entirely through the reservoir and past the dam by way of the spillway and turbines. The water passing over the spillway becomes extremely turbid during spring rains, and, according to observers, remains so during much of the summer. A report published soon after construction of the dam stated:

> Tests * * * have shown that this extremely muddy appearance is due in great part to material which has gone into solution in the water, as at its worst it carries in suspension not more than 1 part of silt in 6,000. It is not anticipated, therefore, that there will be any considerable difficulty from silting of reservoirs on this river. 5/

5/ Sayers, E. L., and Polk, A. C., The Lock 12 development of the Alabama Power Company, Coosa River, Alabama: Trans. Am. Soc. Civ. Eng. vol. 78, no. 1334, p. 1418, 1915.

Table 1.-- Distribution of sediment in Lay Reservoir.

Section	Storage Capacity			Sediment		
	Original	Present	Loss	Volume	Relation to original capacity of reservoir	Relation to total sediment in reservoir
	(Acre-feet)	(Acre-feet)	(Percent)	(Acre-feet)	(Percent)	(Percent)
Coosa River:						
Lower section (Lay Dam to Narrows)......	79,779	70,745	11.32	9,034	5.77	50.18
Middle section (Narrows to Cedar Cr.)	43,504	37,157	14.59	6,347	4.05	35.25
Upper section (Cedar Cr. to Mardis Ferry)..	16,044	15,436	3.79	608	0.39	3.38
Total	139,327	123,338	11.48	15,989	10.21	88.81
Paint Creek............	8,594	7,919	7.85	675	0.43	3.75
Waxahatchee Creek......	4,890	4,299	12.09	591	0.38	3.28
Spring Creek...........	2,003	1,680	16.13	323	0.21	1.79
Slaughter Creek........	736	622	15.49	114	0.07	0.63
Cedar Creek............	518	340	34.36	178	0.11	0.99
Peckerwood Creek.......	457	322	29.54	135	0.09	0.75
TOTAL RESERVOIR........	156,525	138,520	11.50	18,005	11.50	100.00



Longitudinal Section Of Coosa River Section Of Lay Reservoir,

showing originol profile ond original & present overoge depths

The 1936 survey shows that Lay Reservoir actually is silting at a rate sufficient to limit its prospective useful life to a comparatively few generations. This is especially significant in view of the relatively "non-silting" character of the reservoir, and particularly of the low capacity-inflow ratio. The reservoir capacity, which originally was equal to 5.1 days' average inflow, had been reduced in 1936 to only 4.5 days' average inflow. It is obvious, therefore, that appreciable currents through the reservoir normally exist and are tending to increase with reduction of capacity. Consequently much of the suspended sediment does not have time to settle before being carried past the dam.

The capacity loss in all the tributary arms except Paint Creek is higher than the reservoir average of 11.50 percent. In general, the smaller the tributary the greater the percentage of fill.

A curve showing the average thickness of sediment through the main basin would be very irregular, but would show a general decrease in thickness toward the upper end. Average silt depths commonly range from 4 to 6 feet in the lower section and from 2 to 4 feet in the middle section, and are consistently less than 1 foot in the upper section. In the tributary arms the average silt depths are generally less than 3 feet at their lower ends and diminish upstream. In the Paint Creek and Cedar Creek arms, however, silt depths increase again in small deltas at their heads.

The maximum silt depths generally occur along the thalwegs of the various arms, except in the upper section of the main basin. There deposits as much as 9 feet thick have accumulated in narrow strips along both shores of the constricted basin, while strong inflowing currents have permitted the accumulation of only scattered thin deposits of sediment in midchannel.

Origin of sediment.-- The character of the reservoir sediment indicates that it has been derived chiefly from fine-textured soils, rich in iron minerals and containing relatively little sand. A minor proportion no doubt has originated from stream erosion of the old flood-plain deposits or first-bottom lands which extend along many miles of the Coosa River. Wave-cut banks several feet high along the more exposed sections of shore line indicate that an appreciable volume of material has been added to the reservoir sediment by wave erosion.

The results of a study of the watershed point to the origin of a large part of the reservoir sediment in the severely eroding valley soils of the Valley and Ridge province. Other important sources are the steep slopes of the ridges, particularly where their protective cover has been destroyed by deforestation or fire, and the severely eroding cultivated areas of the Alabama Piedmont.

The data in the following statistical summary indicate that sediment is accumulating in the reservoir at the annual rate of 6.04 cubic feet, or approximately 0.3 ton, per acre of drainage area. In view of the large

The following tabulation gives a summary of data relating to Lay Reservoir, Clanton, Ala.

	Quantity	Unit
Age 1/	22.3	Years
Watershed:		
Total Area	9,087	Square Miles
Reservoir:		
Original area at crest stage	6,698	Acres
Present area at crest stage	6,698	Acres
Original storage capacity	156,525	Acre-feet
Present storage capacity	138,520	Acre-feet
Original storage per square mile of drainage area	17.23	Acre-feet
Present storage per square mile of drainage area	15.24	Acre-feet
Sedimentation:		
Delta deposits		
Bottom-set beds	Not measured separately	
Total sediment	18,005	Acre-feet
Accumulation per year average	807	Acre-feet
Accumulation per year per 100 square miles drainage area	8.88	Acre-feet
Accumulation per year per acre of drainage area	6.04	Cubic feet
Or, assuming average weight of 1 cubic foot of silt is 100 pounds	0.30	Tons
Depletion of storage:		
Loss of original capacity per year	0.52	Percent
Loss of original capacity to date of survey	11.50	Percent

1/ Date storage began: December 1913.
Date of this survey (average): May 1936.

U. S. DEPARTMENT OF AGRICULTURE
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LAY RESERVOIR
COOSA RIVER
CLANTON
ALABAMA
SEDIMENTATION SURVEY OF. JAN. 27, - JULY 24, 1936
G. C. DOBSON, Acting Head, Sedimentation Studies, Division of Research
L. M. Seavy, In Charge of Field Survey
2500 0 2500 5000 7500
Scale in feet
LEGEND
Spillway Crest Line
Thalweg of Original Channel
Silt Range
Township Line
Section Line
County Line
Triangulation Station
Plane Table Station
Reservoir Segment Number
CHILTON COUNTY
COOSA COUNTY
SHELBY COUNTY
TALLADEGA COUNTY
SHELBY
CHILTON
Waxahatchee Creek
Paint Creek
Tam Cr.
Spring Cr.
Peckerwood
Cedar Creek
Beeswax
TALLADEGA CO.
COOSA CO.
To Shelby
2-1-37
S-1806